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ELECTRICALLY CONDUCTIVE RESIN COMPOSITION  
[DODENSEI JUSHI SOSEIBUTSU]

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## Specifications

### 1. Title of the Invention

Conductive Resin Composition

### 2. Claim(s)

A conductive resin composition used as an electromagnetic shielding molding material characterized by containing metal fibers and carbon fibers in a synthetic resin and, as further needed, carbon black or graphite, thus giving the surface of a molding satisfactory surface conductivity after the molding step.

### 3. Detailed Specifications

(Field of Industrial Application)

This invention pertains to a conductive resin composition used as an electromagnetic wave shielding molding material for cable connectors and the like, and in particular, it relates to a conductive resin composition which gives the surface of a molding satisfactory surface conductivity after the molding step.

(Prior Art and Problems Thereof)

Digital equipment, such as computers and word processors, have become widely diffused due to recent advancements in office or factory automation. The high frequency noise generated inside such equipment has become a problem during this trend. Measures have been taken against the electromagnetic interference (EMI) in equipment units, cable connectors.

Figure 1 is a perspective view showing a specific example of an ordinary cable connector, shown by the symbol A. This cable connector A is composed

of an insulating member 2 in which connector pins 1, 1 ... 1 are inserted and an exterior member 3. 4 is a bundle of conductors connected to each of the connector pins 1, 1 ... 1.

The exterior member 3 is formed from a metal cover machined from sheet metal as an electromagnetic interference measure for this cable connector A, a metal plating is carried out on the exterior member 3 comprising plastic, etc. It is utilized for improving the surface conductivity of the exterior member 3 intentionally. This is because it is necessary to earth digital equipment at the joint end face of the connector exterior member 3 for the purpose of not allowing conduction noise produced from within the digital equipment to leak out through cables connected externally.

However, it is difficult to cover connectors having complicated shapes with metal by the aforementioned metal sheet working. And because of the metal plating and the base material being plastic, a chemical plating is necessary, which in turn requires a pre-processing, which is not preferable from the standpoint of cost.

In order to improve such a drawback, an EMI shielding compound containing metal fillers is used instead of the metal-plated plastic as the exterior member. Means for forming the exterior member 3 by injection molding or integrating an insulating member with an exterior member which uses the aforementioned EMI shielding compound by double molding have been investigated.

An EMI shielding compound with metal fibers is known for the compound mentioned above, but a skin layer is formed on the surface of the injection

molded molding and no surface conductivity is obtained. Thus, the connector cannot be earthed at the joint end face.

(Object of the Invention)

The object of the present invention is to obtain a conductive resin composition used as an electromagnetic shielding molding material for cable connectors and the like, and in particular, a conductive resin composition for giving the surface of a molding satisfactory surface conductivity and improving the drawbacks existing in the aforementioned known art.

(Gist of the Invention)

In order to achieve the aforementioned object according to the present invention, the titled composition is characterized by containing metal fibers and carbon fibers in a synthetic resin and, as further needed, carbon black or graphite, thus giving the surface of a molding satisfactory surface conductivity after the molding step.

The aforementioned synthetic resin pertaining to the present invention can be any high heat- and temperature-resistant engineering plastic, such as polybutylene terephthalate, nylon-6, nylon-6,6, nylon-12, or polycarbonate. Polybutylene terephthalate and nylon-6,6 are preferable because of their good chemical resistance, strength and thermal deformation temperature balance.

The metal fibers can be any fibers if they are aluminum, cast iron, steel, stainless steel, brass, and the like obtained by cutting by chattering vibration, stainless steel fibers obtained by drawing (SUS 316L, SUS304),

etc. The diameter of the fibers that can be used is  $6\text{ }\mu\text{m}$  to  $70\text{ }\mu\text{m}$ , but preferably, it ranges from  $8\text{ }\mu\text{m}$  to  $50\text{ }\mu\text{m}$ . Moreover, the length of the fibers that can be used is  $0.8\text{ mm}$  to  $9.0\text{ mm}$ , but preferably, it ranges from  $1.0$  to  $6.0\text{ mm}$ .

The amount of the aforesaid fibers added is 20 to 60 wt.% with respect to the fibers obtained by cutting by chattering vibration, but preferably, it from 25 to 45 wt.%. The amount of the stainless steel fibers obtained by drawing is 5 to 30 wt.%, but preferably, it ranges from 5 to 15 wt. %.

Furthermore, the carbon fibers can be either PAN- or pitch-based fibers and they are bundled or unbundled. The ideal fiber diameter is  $5\text{ }\mu\text{m}$  to  $30\text{ }\mu\text{m}$ , but preferably, it ranges from 5 to  $15\text{ }\mu\text{m}$ . The fiber length ranges of  $0.2\text{ mm}$  to  $9.0\text{ mm}$ , but preferably, it is  $0.2$  to  $1.5\text{ mm}$  in the case of unbundled fibers and  $3$  to  $9.0\text{ mm}$  in the case of bundled fibers.

Moreover, it is preferable that the pitch-based fibers be fired at about  $2,000^{\circ}\text{C}$  after being spun and that the fiber surface be graphitized.

The amount of the pitch-based fibers added is 5 to 20 wt.%, and preferably, 5 to 15 wt.%.

The present invention is comprised by containing the aforementioned metal fibers and carbon fibers, but the advantages of the present invention can be improved even more by containing, as further needed, carbon black and/or graphite. Furnace black, acetylene black, funnel black, and the like are cited for the aforementioned carbon black. The amount compounded thereof is 5 to 30 wt.% of the composition, but preferably, it is 5 to 20 wt.%. Moreover, the graphite can be either naturally produced or man-made.

The particle size thereof is 5 to 80  $\mu\text{m}$ . The amount of the graphite compounded is 3 to 15 wt.%, and preferably, it ranges from 3 to 10 wt.%.

In the present invention, each of the aforementioned constituents is compounded at the desired compounding ratio, after which they are kneaded, extruded and granulated by an extruder to get pellets 4 mm in diameter and 3 mm in length. Then the pellets are molded into the desired shape by an injection molding machine, and the same is used. The surface of the obtained molding is given satisfactory surface conductivity, and it can be used as an electromagnetic shielding molding material, such as a molding material for the exterior member 3 for the cable connector A, as shown in Figure 1.

#### (Practical Examples of the Invention)

The present invention will now be explained more specifically through the practical examples.

The samples shown in Table 1 having the respective compounding ratios are compounded in a 20 L super mixer, the respective compounded materials are kneaded, extruded and granulated using a 30 $\phi$  mm vent extruder to mold 4mm diameter, 3 mm long round pellets. The aforesaid obtained pellets are molded into a 50x25x2 (mm) plate at 270°C using a 3.5 ounce injection molding machine.

The surface resistance of the molding was measured by checking the conductivity of the surface of the molded product using a tester. The volume resistance was measured by cutting the end face of the molded plate with a knife, exposing the metal fibers inside the molded product and

applying a silver paste on that part to obtain an electrode, and calculating out the intrinsic volume resistance from the resistance across the electrodes in considering the dimensions of the molding. Moreover, the impact strength was measured by cutting out a 10x60x2 (mm) test piece from the molded product, and cutting prescribed notches into it to get a test piece used in an impact tester. And so the impact strength was measured using this test piece. The results have been shown in Table 1.

Table 1

(Parts by Weight)

Sample No.	1	2	3	4	5	6	7	8	9
Constituent									
Polybutylene terephthalate	50	70			55	50	85		80
Nylon-6,6			55	73				50	
Brass fibers	30		25			50		40	
Stainless steel fibers		10		10			15		10
Aluminum fibers					25				
Carbon fibers	20	20	15	10	15				
Carbon black				7					
Graphite			5		5			10	
Type of sample									10
Surface resistance ( $\Omega$ )	$12.0 \times 10^3$	$4.0 \times 10^3$	$0.8 \times 10^3$	$3.5 \times 10^3$	$4.0 \times 10^3$	No conduction	No conduction	$6.5 \times 10^3$	No conduction
Intrinsic volume resistance ( $\Omega$ cm)	$8.0 \times 10^{-1}$	$12.0 \times 10^{-1}$	$8.0 \times 10^{-1}$	$8.0 \times 10^{-1}$	$3.5 \times 10^{-1}$	$0.2 \times 10^{-1}$	$2.5 \times 10^{-1}$	$0.8 \times 10^{-1}$	$28.0 \times 10^{-1}$
Impact strength (notched, kg-cm/cm)	6.2	6.8	5.8	5.8	5.5	5.8	5.3	3.2	3.4

As seen from Table 1, Sample nos. 1 to 5 (present invention) have more satisfactory surface conductivity than the samples nos. 6 to 9 (comparative examples). The EM shielding effect is at a level that can be expected in relation to the intrinsic volume resistance. It is seen that the impact strength is sufficient for connector use.



### (Advantages of the Invention)

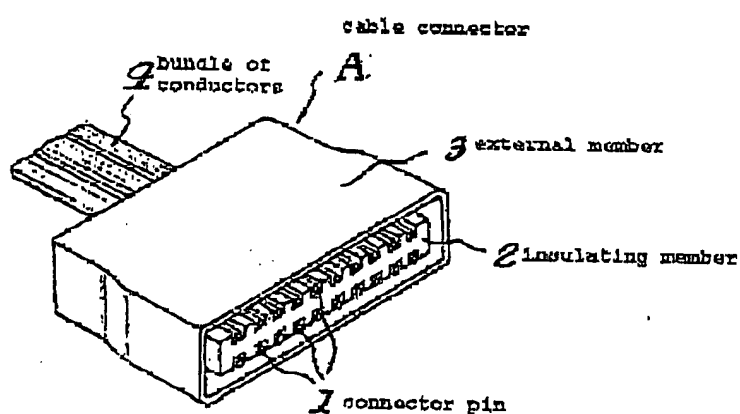
As seen above, the conductive resin composition pertaining to the present invention contains metal fibers and carbon fibers in a synthetic resin, and as further needed, carbon black and/or graphite; hence, it is a composition which gives the surface of a molding satisfactory surface conductivity after molding and is ideal as an electromagnetic shielding molding material for cable connectors, etc.

### 4. Brief Explanation of the Drawings

Figure 1 shows a cable connector to which the composition of the present invention is applied.

A: cable connector; 1: connector pin; 2: insulating member; 3: exterior member; 4: bundle of conductors

Figure 1



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